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Nr. 3. A. C. Johansen: MARKING EXPERIMENTS WITH SOLE (SOLEA VULGARIS QUENSEL) AND TURBOT (RHOMBUS MAXIMUS L.) IN THE KATTEGAT AND BALTIC WATERS

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1916

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MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER
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MARKING EXPERIMENTS

WITH

SOLE (*SOLEA VULGARIS* QUENSEL) AND TURBOT (*RHOMBUS MAXIMUS* L.)

IN

THE KATTEGAT AND BALTIC WATERS

BY

A. C. JOHANSEN

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1916

I. Marking experiments with Sole (*Solea vulgaris* Quensel).

1. Introductory remarks.

In October 1906 we liberated 184 marked soles from the research steamer "Thor" in the northern Kattegat.[1] The fish were captured by a small 50 feet English otter trawl in short hauls of an hour's duration. When captured the fish were apparently quite uninjured, and the liberation took place at the places of capture of which one is situated near Trindelen north-east of Lœsø at a depth of 23—33 metres and another in the northern part of Lœsø-Rende at a depth of 18—37 metres. The label consisted of two bone buttons, which were attached to the fish by means of a silver wire passed through the body at the interspinal bones near the dorsal fin (Fig. 1). The button on the eye side of the fish was provided with a depression, wherein a brass disc with a stamped number was placed. The fish were of a length between 19 and 37 cm.

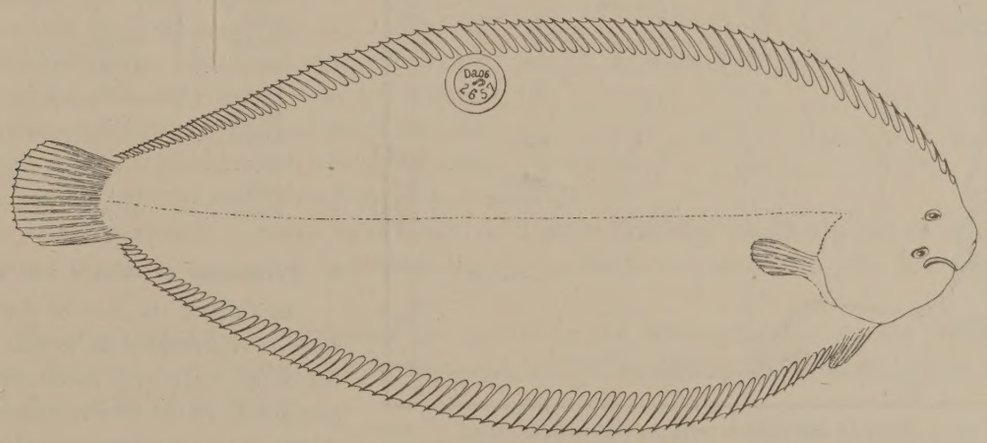

Fig. 1. A marked Sole.

2. The migration of soles.

The chart Fig. 2 illustrates the situation of the places of liberation and the places of recapture for the marked sole. It will be seen that all the places of recapture are situated in the Kattegat and with a few exceptions all in the northern Kattegat, where the liberation took place. One of the specimens liberated near Lœsø Trindel was recaptured 3 months later at Anholt, and one of the specimens from the

[1] A preliminary note about this experiment was published in Rapports et Procès-Verbaux des Réunions.-Vol XVI. Cons. perm. internat. 1913.

experiment in Læsø Rende was recaptured 17 months later south of Anholt. Longer migrations were not observed.[1]

The experiments suggest that the Kattegat has its own stock of soles. All the developmental stages of the sole are also known from the Kattegat.

If we look at the depths at the places of capture for the marked fish during the different months, it will be seen that in April and May the specimens are recaptured in more shallow water on an average than in autumn and winter (Table 1). This is due to the fact that during these spring months the sole moves into the warm coast water in order to spawn. In autumn and winter, when the surface water is considerably colder than the bottom water, they stay at greater depths.[2]

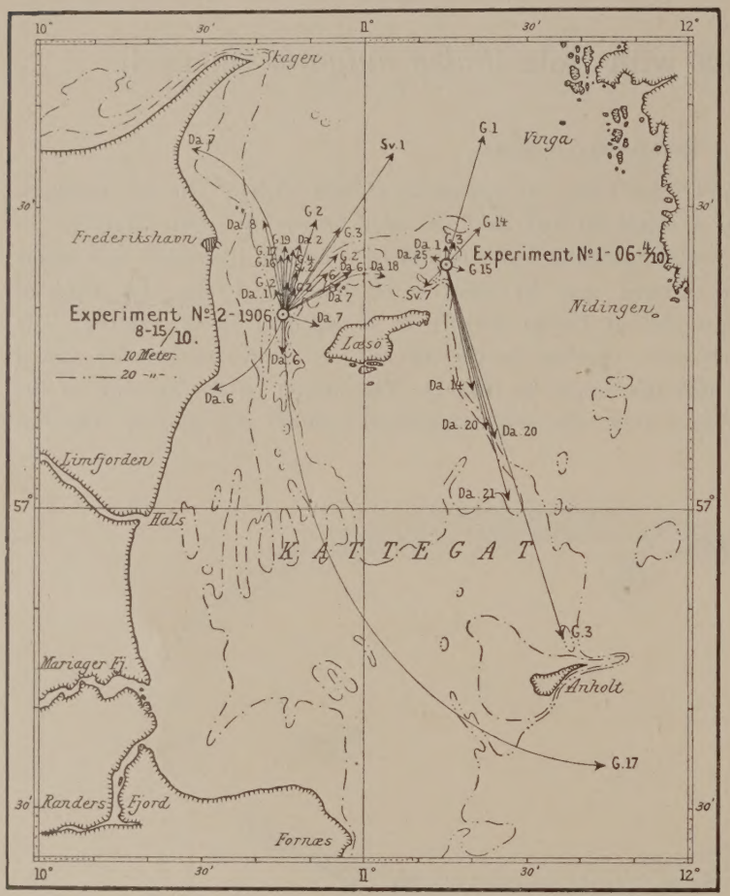

Fig. 2. Marking experiments with Sole in October 1906.[1]

Table 1. Mean-depths in metres at the places of recapture of soles in the various months. (No. of specimens in brackets.)

Experiment No. and Date	No. 1 4. Oct. 1906	No. 2 8.—15. Oct. 1906
1906. Novbr. . . .	32 (2)	31 (2)
Decbr. . . .	. . .	37 (6)
1907. Jan.	43 (1)	38 (1)
Febr.	. . .	41 (1)
April	. . .	9 (3)
May	16 (1)	9 (2)
June.	. . .	26 (1)
Decbr. . . .	46 (2)	. . .
1908. Jan.	41 (1)	—
Febr.	. . .	34 (1)
March . . .	. . .	38 (1)
April	. . .	13 (1)
May	. . .	34 (1)
July	14 (1)	. . .
Novbr. . . .	34 (1)	. . .

3. Percentage of marked sole recaptured.

In Table 2 the size of the liberated soles is represented as well as the number of the recaptured specimens for each size-group. Of 184 liberated soles, 41 specimens or 22·3 % were recaptured altogether:

Of 66 soles of original length 19—24 cm. 21·2 % were recaptured
- 91 — - — — 25—29 - 19·8 - — —
- 27 — - — — 30—37 - 33·3 - — —

[1] The arrow heads on the charts Fig. 2—4 indicate the situation of the places of capture. The letter by the arrow head indicates the nationality of the fishermen. (D = Danish, E = English, G = German, S = Swedish). If the letter is omitted, the fish was caught by a Danish fisherman. The number by the arrow head indicates the number of months which have passed since the liberation took place. O means: "recaptured in the same month in which the liberation took place", 1 means: "recaptured 1 month after liberation", and so on.

[2] That the temperature plays an important rôle with regard to the migrations of the sole has been shown by Rosa M. Lee in "Report on the Grimsby steam trawlers Records". Marine Biol. Assoc. International Investigations. Third Report (Southern Area) 1906—8 (1911), and by H. C. Redeke & I. I. Tesch: "Ueber die wirtschaftliche Bedeutung und die Naturgeschichte der Seezunge". Verh. uit het Rijksinst. voor het Onderzoek der Zee. 1911.

A higher percentage is thus recovered of the large soles than of the small and middle-sized ones.

During the first year after liberation a percentage of 13·6 were recaptured, and in the course of 2 years the percentage rose to 21·6 %. The last recaptured specimen was taken 25 months after liberation.

Among the 41 recaptured soles 18 specimens or 45 % were recaptured by Danish fishermen, 18 by German, 4 by Swedish and one was found in Ymuiden and had perhaps been recaptured by a Dutch fisherman. In spite of the fact that the liberation took place west of the deep channel in the Kattegat, the foreign fishermen have recaptured more specimens than the Danish fishermen.

We here get quite another picture than regarding the plaice.

The Danish marking experiments with plaice in the Kattegat, mainly carried on west of the deep channel, have shown that the Danish fishermen on an average, have taken 85 % of the recaptured marked plaice, and the foreign fishermen only 15 %. The fact that the Danish fishermen have fished a far lower percentage of the recaptured marked soles is to be explained by their employing as a rule the snurrevaad for the capture of flat fish, while the German fishermen use the otter trawl. The snurrevaad, which moves proportionately lightly over the bottom, is excellently adapted for the capture of plaice and haddock, but not quite as good for the capture of soles, because this species squeezes itself more firmly into the bottom. (In order to capture the sole more easily the Danish fishermen frequently put an extra weight on the foot rope of the snurrevaad. — Sometimes the snurrevaad is furnished with otter boards and used as a trawl).

Table 2. Size of Sole on liberation and the No. of specimens of the various size-groups recaptured.

Length in cm	1906					
	Exper. No. 1		Exper. No. 2		Exper. No. 1—2	
	♂+♀		♂+♀		♂+♀	
	Liberated	Recaptured	Liberated	Recaptured	Liberated	Recaptured
19	..	..	1	..	1	..
20	..	..	5	..	5	..
21	..	..	7	2	7	2
22	1	..	14	3	15	3
23	1	..	16	..	17	..
24	2	..	19	9	21	9
25	3	1	22	4	25	5
26	4	..	24	3	28	3
27	4	2	13	3	17	5
28	4	2	9	3	13	5
29	3	..	5	..	8	..
30	2	1	1	..	3	1
31	4	3	1	..	5	3
32	1	..	4	..	5	..
33	3	2	3	..	6	2
34	2	1	..	..	2	1
35	1	1	..	..	1	1
36	3	.	..	..	3	..
37	2	1	..	..	2	1
	40	14	144	27	184	41
% recapt...		35 %		18·8 %		22·3 %

The statistical information concerning the capture by the different nations gives a rather similar picture of the distribution as the marking experiments. In "Bulletin Statistique" the capture in kg is for the different nations stated as follows:

	Sweden	Denmark	Germany
1906		115808	61721
1907	189	68700	54225
1908	370	48055	73782
1909	2690	59059	47873
1910	2424	72893	65462

4. Rate and growth of marked sole.

The Tables 3—4 show the growth of the liberated marked soles. In comparison with the growth of the plaice, the growth of the grown up sole is slow. The small specimens of a length of 21—24 cm. have, on an average, increased more quickly than the middle-sized ones of 25—29 cm., and these show

again a more rapid growth than the large ones of a length of 30—37 cm. The most rapid growth was noticed in 2 specimens which were of a length of 21 cm. on liberation. Seventeen months later they were both of a length of 28 cm. The average growth of specimens of a length of 25—29 cm. was only 1—2 cm. in a year, and in the large specimens of 30—37 cm. a growth of only 0·5—1 cm. was noticed within two years.

Table 3. Rate of growth of soles of 21—24 cm., liberated in the northern Kattegat in October 1906. Marking experiments No. 1—2.

Month recovered	Period between liberation and recovery	Increase in cm.			No. of specimens measured	Initial length in cm. (21—24 cm.)		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1906 November	1 month	0	..	..	2	23	22	24
» December	2 months	0·2	0	1	5	23·6	22	24
1907 January	3 —	0	..	..	1	24	..	..
» February	4 —	0	..	..	1	24	..	..
» April	6 —	0	..	..	1	24	..	..
» May	7 —	1	1	1	2	23	22	24
1908 March	17 —	7	7	7	2	21	21	21

Table 4. Rate of growth of soles of 25—29 cm., liberated in the northern Kattegat in October 1906. Marking experiments No. 1—2.

Month recovered	Period between liberation and recovery	Increase in cm.			No. of specimens measured	Initial length in cm. (25—29 cm.)		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1906 November	1 month	0	..	..	2	27	27	27
» December	2 months	0	..	..	2	25·5	25	26
1907 January	3 —	0	..	..	3	27·3	26	28
» April	6 —	0	..	..	3	25·7	25	27
» May	7 —	0	..	..	1	26	..	..
» June	8 —	1	..	..	1	28	..	..
1908 January	15 —	3	..	..	1	25	..	..
» February	16 —	3	..	..	1	28	..	..
» April	18 —	0	..	..	1	27	..	..
» May	19 —	0	..	..	1	27	..	..
» June	20 —	0·5	0	1	2	26·5	25	28

Table 5. Rate of growth of soles of 30—37 cm., liberated in the northern Kattegat SSW. of Trindelen. October 1906. Marking experiment No. 1.

Month recovered	Period between liberation and recovery	Increase in cm.			No. of specimens measured	Initial length in cm. (30—37 cm.)		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1907 January	3 months	0	..	..	1	34	..	..
» May	7 —	0	..	..	1	31	..	..
» December	14 —	0	..	..	2	33·5	30	37
1908 January	15 —	0	..	..	1	31	..	..
» July	21 —	0·5	0	1	2	34	33	35
» November	25 —	1	..	..	1	33	..	..

In determining the age by means of measurement and by otoliths I have found that soles of the 0-Group in the northern Kattegat were of an average length of 6—7 cm. in October, and that soles of the I-Group were of an average length of 13—15 cm.[1] in August. By means of otoliths and vertebrae THIELEMANN has determined the age of soles of the following size from the southeastern part of the North Sea[2]:

2 specimens	20 cm.	♂ and ♀	I Gr.	Helgoland	October 30. 1912	
2	—	21 - ♂ - ♀	I -	—	— - —	
1	—	32 - ♂	III -	Southeastern North Sea.	March 2. 1912	
1	—	33 - ♀	III -	—	—	— 7. —
1	—	32 - ♂	IV -	—	—	Jan. 7. 1913
1	—	36 - ♀	IV -	—	—	Febr. 16. 1913
1	—	38 - ♀	V -	—	—	March 2. 1912
1	—	42 - ♀	VII -	—	—	Jan. 7. 1913
1	—	43 - ♀	IX -	—	—	Febr. 15. 1913
1	—	41 - ♀	X -	—	—	Jan. 7. 1913

These age-determinations suggest that the growth of the sole takes place relatively quickly during the first 2—3 years of its life, and the marking experiments have quite confirmed this. The slow growth commences when the fish approaches maturity (at an age of ca. 3—5 years).

5. Some previous experiments with the marking of soles.

In the treatise: "Report on experiments with marked fish during 1902—03"[3] W. GARSTANG mentions some marking experiments with soles, carried out on behalf of England in the southwestern part of the North Sea in August and September 1903. — During August 101 soles were marked and set free off Norfolk and Lincolnshire. The main part of the fish had a size of 20—34 cm.

Only two recaptures were reported, neither of which showed any evidence of growth. One sole was recaptured in July 1904 near the place of liberation, another had travelled about 85 miles northwards in six months.

In September 1903 9 marked soles were set free off Terschelling Light-vessel. Only one of these, a specimen of 30 cm., was recaptured, probably in the vicinity of Texel.

From these experiments it seems that labels of the same kind were used as those generally employed by the English for plaice marking.

In a "Report on the experiments with marked fishes made during the year af 1913"[4] JAS. JOHNSTONE and T. MONAGHAN mention some smaller marking experiments with soles carried out in the eastern part of the Irish Sea. About this they write as follows (p. 155—156):

"An attempt was made to mark soles. This had previously been attempted, using the same mark as in the case of plaice, but the results were quite unsuccessful. In 1913 we got some 50 special labels made. Each was a strip of thin sheet silver about 1 cm. in width and about 2 cms. in length. At one end of this strip a little tongue of metal projected out, and was then turned up at right angles to the surface of the strip; at the other end was a little hole. The strip was bent on itself so that the little tongue fitted into the hole. Each label was marked L 1 to L 50. It was fixed to the fish by clasping it on the free border of the operculum on the coloured side, squeezing the bent strip of sliver by means of pliers

[1] A. C. JOHANSEN: Fünfter Bericht über die Pleuronectiden in der Ostsee. Vol. XXII. Rapport & Procès-Verb. cons. perm. internat. 1915.

[2] M. THIELEMANN: Einige Beobachtungen über das Wachstum der Seezunge ... im nordfriesischen Wattenmeer. Wissensch. Meeresunters. N. F. XI. Bd., Abt. Helgoland, Heft. 2, 1916.

[3] Marine Biol. Assoc. International Fishery Investigations I (Southern Area) 1902—03 (1905).

[4] Report (No. XXII for 1913) on the Lancashire Sea-Fisheries Laboratory. Liverpool 1914.

until the tongue was forced through the opercular into the hole on the other end of the strip. The labels were obtained towards the end of the season, so that it was only possible to make one experiment, and then only 14 soles were marked. So far only one of these fish has been recaught, so that it is impossible to say whether or not the method is likely to become a successful one".

In comparison with these English experiments the Danish ones appear to have given very satisfactory results.

Table 6. Particulars regarding the Danish marking experiments with soles in the Kattegat in 1906.

Particulars of Liberation. Date. Locality. No. of Fish etc.	Date	No. on Label	Locality reported	Central position (approximately) N E	Nationality of fishing vessel	No. of months between liberation and recovery	Sex	Initial size cm.	Ultimate size cm.	Initial weight g.	Ultimate weight g.	Remarks
1906. October 4. 3 miles SSW of Trindelen. 57° 24′ N, 11°15′ E. 23—33 metres "Thor" St. 815. 40 soles liber. (No. 3101-3140). "Thor"'s marking experiment No 1 1906.	1906 Novbr. 17	3104	At Trindelen. 17 m.	57°25′ 11°15′	Danish	I		27	27	200		living
	» » 20	3131	8 miles E of Vinga. 47 m.	57°36′ 11°22′	German	I	♀	27	27	200		fresh
	1907 January 14	3138	Kattegat, Anholt		»	III	♂	28	27	200		
	» » 25	3133	Trindelens Light-vessel. 43 m.	57°26′ 11°16′	»	III	♀	34	33·5	480	415	
	» May 8	3112	SW of Trindelen, 1½ miles fr. shore. 15-17 m	57°22′ 11°11′	Swedish	VII		31	31	310		
	» Decbr. 17	3109	ENE of Trindelen's Light-vessel. 54 m.	57°28′ 11°21′	German	XIV		30	30	260		
	» » 19	3125	Kobbergrunden. 38 m.	57°12′ 11°20′	Danish	XIV		37	37·5	580		good
	1908 January 13	3108	S of Trindelen's Light-vessel. 41 m.	57°23′ 11°18′	German	XV		31	31	360		
	» June c. 25	3122	Close S. of Kobbergrunden's Light-vessel	57°08′ 11°23′	Danish	XX		28	28·5	200	215	
	» » c. 25	3130	S of Kobbergrunden's Light-vessel	57°07′ 11°24′	»	XX		25	26·5	160	190	
	» July 7	3110	E of Læsø. C. 14 m.		Swedish	XXI		33	33·5	370		
	» » c. 28	3121	Between Anholt and Læsø		Danish	XXI		35	36·5	490	525	
	» Novbr. 10	3113	SW of Trindelen. 34 m.	57°24′ 11°14′	»	XXV		33	34	310		good
	? ?	3119	?		»	?		31	?			
1906. October 8. —15. Læsø Rende. Off the NW Reef. 57°19′ N, 10°45′ E. 18—37 metres. "Thor" St. 828. 144 soles liber. (No. 3141-3284). "Thor"'s marking experiment No. 2 1906.	1906 Novbr. 22	3248	Læsø Rende. 24 m.		Danish	I		22	22·5	120		living
	» » 29	3261	SE of Skagen. 38 m.	57°35′ 11°05′	Swedish	I		24	23·5	145		
	» Decbr. 9	3259	Læsø Rende. 38 m.	57°22′ 10°46′	German	II		24	24·5	155		
	» » 18	3201	SE of Hirsholmene. 38 m.	57°26′ 10°48′	Danish	II		22	22	120		living
	» » 19	3210	Læsø Rende. 38 m.	57°23′ 10°47′	Swedish	II		26	25·5	160		
	» » 19	3271	Læsø Rende. 38 m.	57°21′ 10°47′	German	II	♀	25	24·5	170		
	» » 22	3208	Læsø Rende. 34 m.		»	II	♀	24	24	160	129	
	» » 24	3239	57°25′ N, 10°55′ E.	57°25′ 10°55′	»	II	♀	24	24	160	77	dry [2]
	» » 24	3183	57°28′ N, 10°51′ E. 34 m.	57°28′ 10°51′	»	II	♀	24	20·5	140		
	1907 January 3	3276	8—10 miles ESE of Hirsholmene. 38 m.	57°27′ 10°55′	»	III		26	25	155		
	» » 4	3172	?		»	III		24	24·5	145	125	gutted
	» » 7	3256	?		»	III		28	28	240	192	gutted
	» February 8	3159	At Frederikshavn. 38—43 m.	57°25′ 10°47′	»	IV		24	23	140		
	» April 11	3146	NW of Nordre Rønner. Læsø. 13 m.	57°23′ 10°53′	Danish	VI		27	26·5	190		living
	» » 14	3255	4 miles W of Læsø	57°16′ 10°45′	»	VI		25	25	170		
	» » 22	3254	Vorsaa at Sæby. 3 m.	57°12′ 10°32′	»	VI		24	24	155		tail dry [1]
	» » 22	3266	NE of Nordre Rønner, Læsø. 11 m.	57°23′ 10°58′	»	VI		25	25	170		living
	» May 4	3211	N of Nordre Rønner, Læsø. 8 m.	57°22′ 10°55′	»	VII		22	23	120		living
	» » 20	3171	W of Læsø harbour. 9 m.	57°18′ 10°51′	»	VII		26	26·5	175		good
	» » 24	3260	Off Aalbæk, 1 mile from land	57°35′ 10°28′	»	VII		24	25	150		good
	» June 21	3198	SE of Hirsholmene. 26 m.	57°28′ 10°42′	»	VIII		28	28·5	250		notgood [1]
	1908 January 14	3269	(Found in Ymuiden)		German or Dutch	XV	♀	25	28·5	155		sound
	» February 29	3149	ESE of Frederikshavn. 34 m.	57°25′ 10°46′	German	XVI		28	31	250		
	» March 2	3182	ESE of Frederikshavn. 38 m.	57°25′ 10°47′	»	XVII		21	28	110		
	» » 22	3220	10 miles S. of Anholt	56°35′ 11°44′	»	XVII		21	27	90		dried [2]
	» April 4	3283	E of Nordre Rønner, Læsø. 13 m.	57°23′ 11°04′	Danish	XVIII		27	27·5	200		good
	» May 18	3257	ESE of Frederikshavn. 34 m.	57°25′ 10°45′	German	XIX		27	26	210		

[1] When calculating the growth 0·5 cm. in added.
[2] — — — 1 - . —

II. Marking experiments with Turbot. (*Rhombus maximus* L.)

A. Experiments in the Kattegat and Great Belt.

In October 1906 we liberated 19 marked turbot caught by the research steamer "Thor" in the northern Kattegat. The fish were caught in a small 50 feet English ottertrawl and they were quite uninjured when liberated. The label which was of the same kind as that used for the marking experiments with soles (see p. 3) was fixed on the body close to the dorsal fin. The fish were of a length of between 25 and 42 cm. on liberation.

The migrations of these turbot are illustrated in Fig. 3. All the specimens captured, except one, were taken in the northern Kattegat at a rather inconsiderable distance from the place of liberation and in the course of 1 to 27 months after liberation. One single specimen was recaptured S. of Anholt 40 months after liberation. Of the 19 turbot liberated 14 specimens or ca. 74 % were recaptured (Table 7), 9 of these during the first year after liberation, 2 during the second, 2 during the third, and 1 during the fourth year. Eight of the specimens were recaptured by Danish fishermen, six by German trawlers.

Table 7. Showing the size of turbot on liberation in the northern Kattegat in October 1906 and the specimens of the various size-groups recaptured.

Exper. 1—2. 1906.

Length in cm.	Liberated	Recaptured
25	2	[1]
27	1	1
28	2	
29	3	3
30	3	2
31	1	1
32	1	1
33	2	1
34	1	1
35	1	1
38	1	1
42	1	1
	19	14

The growth of the recaptured fish is illustrated in Table 8. Three specimens of a length of 27—31 cm., recaptured ca. 1 year after liberation, had grown respectively 2, 3 and 6 cm. or 3·7 cm. on an average. One specimen of 35 cm., recaptured in January 1908 had increased 3 cm. Of two specimens of 30 cm., recaptured about 2 years after liberation, the one had not increased, while the other had grown ca. 5 cm. One specimen

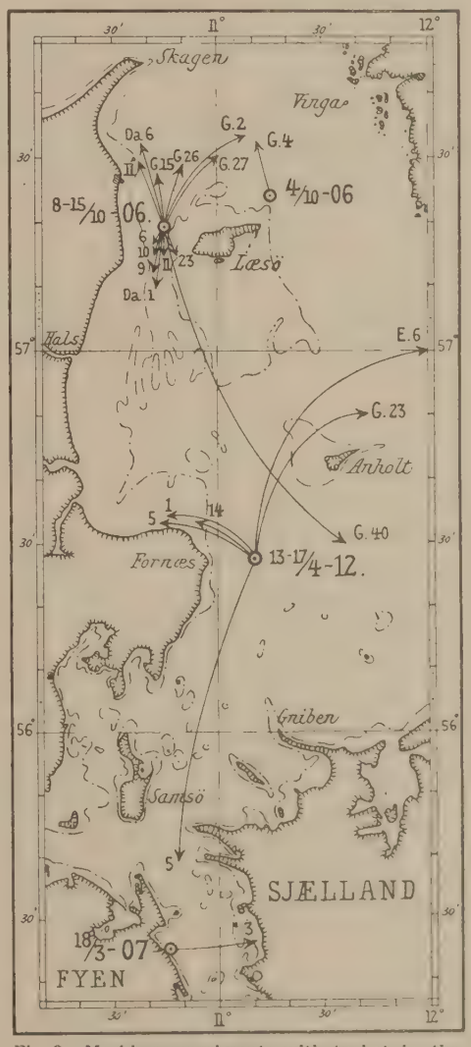

Fig. 3. Marking experiments with turbot in the Kattegat and Great Belt.

Table 8. Growth of turbot liberated in the northern Kattegat in October 1906. (Exper. No. 1 and 2. 1906).

Month recaptured	Period between liberation and recapture	Increase in cm.			No. of specimens measured	Initial length in cm.
		Average	Minimum	Maximum		
1906 Nov. ..	1	0	..	..	1	34
Dec. ..	2	0	..	..	1	33
1907 Febr. .	4	0	..	..	1	42
April .	6	1	0	2	2	29, 32
July ..	9	0	..	..	1	29
Aug. ..	10	3	..	..	1	29
Sept...	11	4	2	6	2	27, 31
1908 Jan. ..	15	3	..	..	1	35
Sept...	23	0	..	..	1	30
Dec. ..	26	7	..	..	1	38
1908 Jan. ..	27	5	..	..	1	30

of 38 cm., recaptured a little more than 2 years after liberation, had increased 7 cm. in length.

According to my age-determinations by means of measurements and otoliths, the turbot in the northern Kattegat increase on an average in length 8—10 cm. yearly in the three first years. The marking experiments show that the growth is much slower after that time.

In the southwestern Kattegat off Fornæs 10 marked turbot, caught in a snurrevaad from a Danish cutter, were liberated in April, 1912. The place of liberation and the position of the places

Table 9. Particulars regarding the Danish marking experiments with turbot in the Kattegat and Great Belt in 1906—1907.

Particulars of liberation. Date. Locality. No. of fish etc.	Date	No. on label	Locality reported	Central position (approximately)	Nationality of fishing vessel	No. of months between liberation and recapture	Initial size cm.	Ultimate size cm.	Initial weight g.	Ultimate weight g.	Remarks
				N E							
1906. October 4. 3 miles SSW of Trindelen. 57° 24′ N, 11°15′ E. 23—33 m. "Thor" St. 815, 1 turbot liberated (No. 3401). "Thor"s marking experiment No. 1 1906.	1907 February 5	3401	6—7 miles N. by W. of Trindelens Lightship. 41 m	57°32′ 11°11′	German	IV	42	42	1670		
1906. October 8. —15. Læsø Rende. 57°19′ N, 10° 45′ E, 18—37 m. "Thor" St. 828—840, 18 turbot liberated (No. 3402—3419). "Thor"s marking experiment No. 2 1906.	1906 Novbr. 14	3406	3 miles S of Læsø-Rende Lightship. 13 m.	57°10′ 10°43′	Danish	I	34	34	770		
	» Decbr. 12	3405	57°33′ N. 11°8′ E. 40—45 m.	57°33′ 11° 8′	German	II	33	33	660	506	cleaned
	1907 April 18	3414	N. of Hirsholmen. 21 m.	57°32′ 10°38′	Danish	VI	29	31	460		living
	» » 26	3412	Læsø Rende. 23 m.		»	VI	32	32	570		living
	» July 31	3417	About 3/4 mile S of Læsø-Rende Lightship. 21 m.	57°12′ 10°42′	»	IX	29	29	470		good
	» August 16	3404	Læsø Rende. 15 m.		»	X	29	32	570		
	» Septbr. 10	3416	SE of Hirsholmen. 6 m.	57°29′ 10°38′	»	XI	27	33	390		living
	» » 22	3418	Læsø Rende. 26 m.		»	XI	31	33	580		
	1908 January 26	3407	5 miles E. of Frederikshavn. 34 m.	57°27′ 10°43′	German	XV	35	38	780		
	» Septbr. 25	3413	SSE of Læsø NW-Reef' Light. 9 m.	57°15′ 10°48′	Danish	XXIII	30	30	450		
	» Decbr. 16	3403	57°28′ N, 10°50′ E. [c. 35]	57°28′ 10°50′	German	XXVI	38	45	920		
	1909 January 20	3409	57°30′ N, 11°0′ E. [c. 40]	57°30′ 11° 0′	»	XXVII	30	35	535		
	1910 February 2	?	S of Anholt		»	XXXX	[25-33]	37			unnumbered
1907 March 18. Entrance to Kerteminde-Bay. 55°25′ N, 10°46′ E. 17 m. "Thor"s St. 895. 1 turbot liberated. No. 3420.	1907 June 15	3420	4 miles SE of Musholm, Great Belt	55°26′ 11°10′	Danish	III	30		470	c. 500	

of capture are illustrated in Fig. 3. It will be seen that these fish, on an average, were recaptured at a greater distance from the place of liberation than the specimens in the northern Kattegat. Six specimens in all, or 60 %, were recaptured. Three of these specimens were taken off the coast of Djursland, respectively 1, 5 and 14 months after liberation. Two specimens were recaptured NE of Anholt 6 and 23 months after liberation, and 1 specimen was taken in the Great Belt off Asnæs 5 months after liberation. Four specimens were recaptured by Danish fishermen, one specimen by an English trawler and one by a German trawler.

In the Great Belt off Kerteminde a marked turbot of a length of 30 cm. was liberated on March 18th 1907. During the following summer it was recaptured on the other side of the Great Belt in Musholm Bay.

Of 30 turbot liberated in the Kattegat and Great Belt 21 specimens, or 70 %, were recaptured in all. Of these 13 specimens, or 62 %, were recaptured by Danish fishermen and 8 specimens, or 38 %, by foreign trawlers.

Table 9. Particulars regarding the Danish marking experiments with turbot in the southwestern Kattegat in 1912.

Particulars of liberation, Date, Locality, No. of fish etc.	Date	No. of Label	Locality reported	Central position (approximately) N E	No. of months between liberation and recapture	Nationality of fishing vessel	Initial size cm.	Ultimate size cm.	Remarks
1912, April 13.—17, c. 5—10 miles E of Fornæs. 56° 28′ N, 11°11′ E. 10 turbot liberated (No. 470—79).	1912 May 15	472	0·5 miles N of Stavnshoved. 11 m.	56°34′ 10°47′	I	Danish	38	38	living, 1·1 kg.
	» Septbr. 11	479	NW of Stavnshoved. 8 m.	56°33′ 10°45′	V	»	?	26·5	living.
	» » 27	473	1 mile W of Asnæs. 22 m.	55°40′ 10°49′	V	»	39	[39]	1275 gr.
	» Octbr. 27	478	57°0′ N, 12° E. 15—34 m.	57°00′ 12°00′	VI	English	?	38	870 gr.
	1913 June 16	476	c. 7 miles N. of Fornæs. 12 m.	56°33′ 10°56′	XIV	Danish	?	44	2 kg
	1914 March 1	477	6 miles NNE of Anholt. 32 m.	56°50′ 11°42′	XXIII	German	?	44	

B. Experiments in the true Baltic at Bornholm.

In May 1913 100 marked turbot of a length from 19—41 cm. were liberated at the western and southwestern coasts of Bornholm. The fish were recaptured in nets by fishermen from Bornholm, and the marking was carried out by Hr. KRISTIANSEN of the Fishery Inspection. The liberation took place close to the place of capture. As labels were used two silver plates fixed under the dorsal fin, one at each side of the body. To one of the plates was plumbed a short silver wire. The other plate was numbered.

This label proved to be very durable, but it appeared, however, to be inferior to the label which has usually been employed by Danes of late years, consisting of two bone buttons with brass discs, fastened by a silver wire. In several cases the fish suffered more than usually by the marking, as the sharp edges of the silver plate irritated the skin. Most of the fish recaptured were, however, uninjured.

The liberation of the fish took place in three different places in the vicinity of the coasts of Bornholm. (See Fig. 4). Twenty specimens were liberated 3 miles west of "Hammeren" at 24 metres' depth. Fifty-three specimens were liberated 3 miles WSW of Rønne, and 27 specimens south of Arnager at 13 metres' depth.

1. Migrations.

Fig. 4 illustrates the places of liberation and recapture of the marked fish. It is characteristic that all the places of recapture except one are situated near the coasts of Bornholm. One single specimen was recaptured off the coasts of Sweden 25 months after liberation.

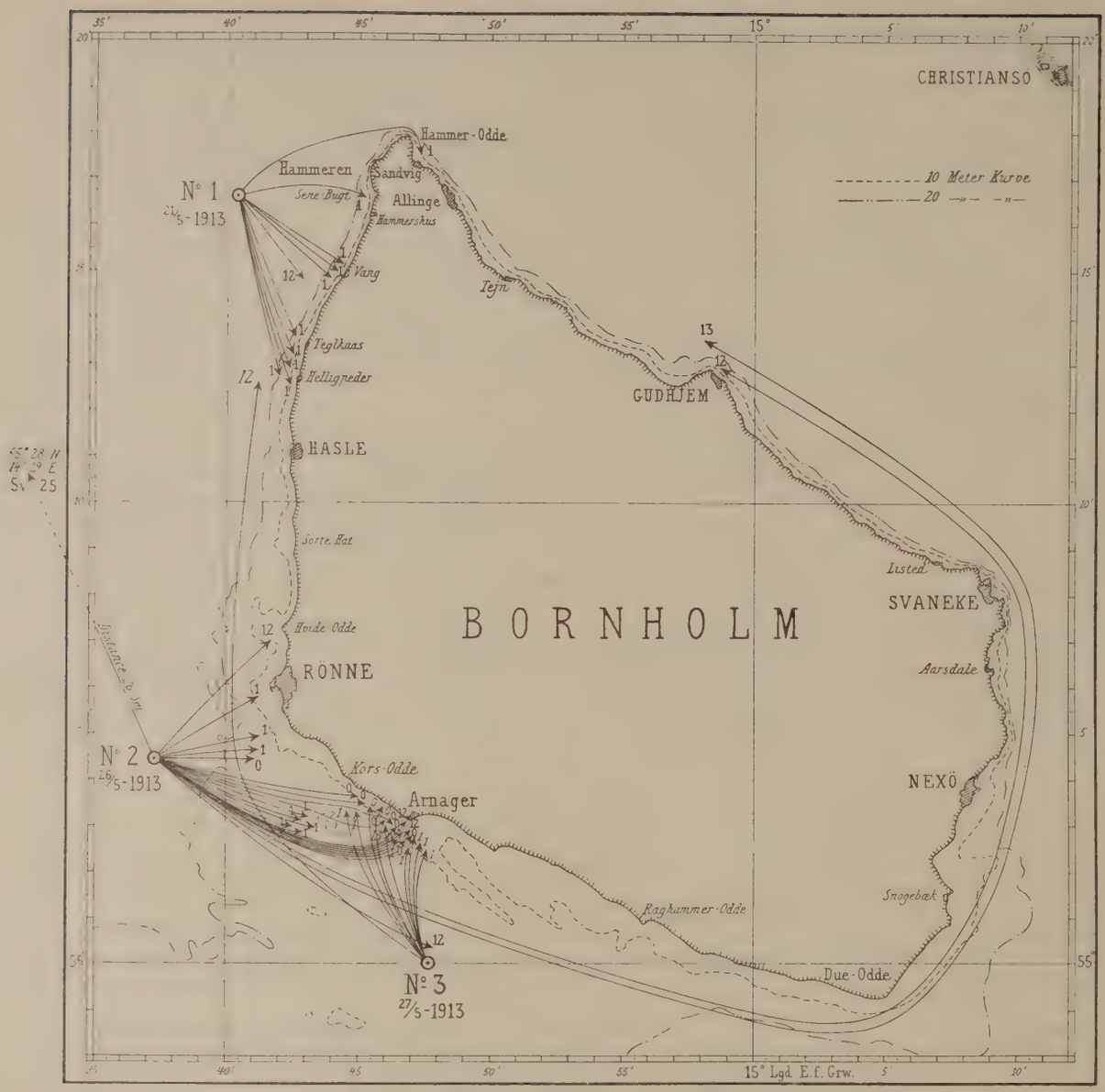

Fig. 4. Marking experiments with turbot in the Baltic at Bornholm in May 1913.

If we regard the figures by the arrow points off the coasts of Bornholm it will be seen that these only comprise the numbers 0, 1, 2, 12 and 13. They indicate the number of months between liberation and recapture, and as the liberation took place in May, all the recaptures fall thus within the months May—July.

This is in connection with the fact that the turbot fishery is only carried on during the months April—July off the coasts of Bornholm.

All the places of recapture marked 0, 1 and 2 are situated nearer to the coast and in shallower water than the places of liberation. This corresponds with the fact that the fish in the months of May

and June migrate into shallower water in order to spawn. In experiment No. 3 in which 27 marked fish were liberated, eight of those were recaptured during the months May and June in a sector of about 30°, and in experiment No. 2 in which 53 marked fish were liberated, eighteen of those were recaptured during May and June in a sector of about 60°.

Thus the marked fish cannot have migrated equally into all directions, but they have shown a preference for migration towards the shallower water off the coasts.

In May and June 1914 9 marked turbot were recaptured, 7 of those at the west- and southwest-coast and 2 at the east coast by Gudhjem. These latter originate from the experiment near Rønne. Whether they have passed around the isle North or South cannot be ascertained.

The recapture of one specimen off the southern coasts of Sweden near Skillinge at 16 metres' depth 25 months after liberation is worthy of note. The stock of turbot at Bornholm is thus in contact with the stock off the Swedish coasts, and in all probability also with the stock off the Baltic coasts of Germany.

2. No. of marked turbot recaptured.

Table 10 shows the size of the specimens liberated and the number of recaptures of each size-group. Of 100 specimens liberated 46 were recaptured in all. Thirty-six specimens were recaptured during the first two months after liberation, and seven specimens during the rest of the year. The percentage of all the recaptured fish of different size-groups was as follows:

	No. liberated	No. recaptured	% recaptured
19—24 cm....	33	15	45·5
25—29 - ...	53	27	50·9
30—34 - ...	11	4	36·4
35—41 - ...	3	0	0·0

This shows that a greater percentage were recaptured of those of average size than of the smaller as well as of the larger fish.

The percentage of recoveries was in the case of the experiment west of Hammeren 55 %, in that SW of Rønne 47·2 % and S of Arnager 37 %.

Among the 46 recaptured marked turbot, 45 were caught by Danish fishermen in the vicinity of Bornholm and one specimen was taken by a Swedish fisherman near the coasts of Sweden.

Table 10. Size of turbot on liberation and the specimens of the various size-groups recaptured. Experiments at Bornholm 1913.

Length in cm.	Exp. No. 1		Exp. No. 2		Exp. No. 3		Total	
	Liberated	Recaptured	Liberated	Recaptured	Liberated	Recaptured	Liberated	Recaptured
19	..	..	1	..	..	..	1	..
20	..	..	1	..	..	..	1	..
21	..	..	2	2	..	..	2	2
22	..	..	6	1	3	2	9	3
23	..	..	8	5	4	3	12	8
24	2	..	4	2	2	..	8	2
25	4	3	7	6	5	2	16	11
26	1	1	5	2	3	1	9	4
27	4	2	6	2	4	2	14	6
28	1	1	5	3	2	..	8	4
29	2	2	3	..	1	..	6	2
30	3	1	1	..	1	..	5	1
31	1	..	3	2	..	..	4	2
32	..	..	..	..	..	..	..	..
33	..	..	..	..	1	..	1	
34	1	1	..	..	..	..	1	1
35	..	..	..	..	..	..	..	..
36	..	..	..	..	1	..	1	
37	..	..	..	..	..	..		
38	..	..	..	..	..	..		
39	..	..	..	..	..	..	..	..
40	..	..	..	..	..	..	..	..
41	1	..	1	..	..	..	2	..
Total...	20	11	53	25	27	10	100	46

3. Rate of growth of marked turbot at Bornholm.

It will be seen from Table 11, that the growth of 9 specimens of a length of 21—26 cm only amounted to 0—1 cm, or, on an average, 0·8 cm, during a year. This slight growth is connected with the fact that the turbot of the quoted size at Bornholm is mature[1] and of rather

[1] A. C. Johansen: Fünfter Bericht über die Pleuronectiden in der Ostsee. Vol. XXII. Rapports et Procès-Verbaux Conseil perm. Internat. Copenhague 1915 p. 32.

considerable age. One single specimen of a length of 27 cm increased during two months from 27—29 cm, and one specimen of 31 cm increased from 31—35 cm during twenty-five months.

It will be seen that the growth of the turbot at Bornholm is much inferior to the growth in the northern Kattegat (see p. 9—10).

Table 11. Growth of turbot liberated at Bornholm in May 1913.

Month recaptured	Period between liberation and recapture	Increase in cm.			No. of specimens measured	Initial length in cm.		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1913 May	1—5 days	0	0	0	10	24·4	21	28
June	I month	0	0	1	25	26·5	23	34
July	II months	2	..	..	1	27	..	..
1914 May	XII —	0·9	0	1	7	23·9	21	26
June	XIII —	0·5	0	1	2	23·5	22	25
1915 June	XXV —	4	..	..	1	31	..	..

Table 12. Particulars regarding the Danish Marking experiments with turbot in the Baltic at Bornholm in 1913.

Particulars of liberation. Date. Locality. No. of fish etc.	Date	No. on label	Locality reported	Central position (approximately)		No. of months between liberation and recapture	Nationality of fishing vessel	Sex	Initial size cm.	Ultimate size cm.	Growth (approximately)	Remarks
				N	E							
1913. May 21. 3 miles NW of Vang (Bornholm). 56°16′,5 N. 14°40′,5 E. 24 m. 20 turbot liberated (Da 13, No. 101—20) Marking experiment No. 1, 1913	1913 June 6	107	0·5 miles WSW of Helligpeder. 9 m.	55°12′,5	14°42′,5	I	Danish	♀	25	25	0	good
	» » 6	109	0·5 miles NW of Vang. 13 m.	55°15′	14°44′	I	»	♂	26	26	0	»
	» » 6	119	0·5 » » » » 13 »	55°15′	14°44	I	»	♂	28	28	0	»
	» » 8	106	1 mile NW of Teglkaas. 16 m.	55°13′,5	14°42′,5	I	»	♂	34	34	0	»
	» » 13	101	0·5 miles NNW of Vang. 16 m.	55°15′,5	14°44′	I	»	♀	29	29	0	»
	» » 13	105	1 mile W of Teglkaas. 13 m.	55°13′	14°42′,5	I	»	♀	27	27	0	slightly injured
	» » 14	104	1 mile NW of Helligpeder. 13 m.	55°13′	14°42′	I	»	♀	29	[30]	1	good
	» » 14	117	1 » » » » 13 »	55°13′	14°42′	I	»	♀	25	25	0	»
	» » 16	108	0·5 miles NE of Sandvig. 9 m.	55°17′,5	14°47′,5	I	»	♀	30	30	0	slightly injured
	» July 1	112	0·5 miles W of Senehavnen. 9 m.	55°16′,5	14°45′	II	»	♀	27	29	2	good
	1914 May 7	113	1 mile W of Vang. [23 m.]	55°15′	14°43′	XII	»		25	26	1	slightly injured
1913. May 26. WSW of Rønne, 3 miles from shore. 55°04′,5 N. 14°37′ E. 26 m. 53 turbot liberated (Da 13, No. 121—73) Marking experiment No. 2, 1913	1913 May 26	145	W of Arnager. 11 m.	55°03′	14°46′	0	Danish	♀	22	22	0	good
	» » 26	170	» » » 11 »	55°03′	14°46′	0	»	♀	23	23	0	»
	» » 29	127	3 miles S of Rønne. 9 m.	55°03′,5	14°45′	0	»		27	27	0	
	» » 29	173	3 » » » » 9 »	55°03′,5	14°45′	0	»		25	25	0	
	» » 31	121	0·5 miles S of Arnager. 9 m.	55°02′,5	14°47′,5	0	»	♂	28	28	0	slightly injured
	» » 31	139	0·5 » » » » 9 »	55°02′,5	14°47′,5	0	»	♂	21	21	0	good
	» » 31	142	0·5 » » » » 9 »	55°02′,5	14°47′,5	0	»	♀	27	27	0	»
	» » 31	153	0·5 » NW of Arnager. 11 m.	55°03′	14°46′	0	»	♂	25	25	0	»
	» June 1	134	1 mile S of Rønne. 11 m.	55°05′	14°41′	I	»		31	31	0	
	» » 2	125	1 » » » » 13 »	55°05′	14°41′	I	»	♀	23	23	0	good
	» » 2	130	0·5 miles W of Rønne. 9 m.	55°06′	14°41′	I	»	♀	26	26	0	»
	» » 5	132	1 mile S of Rønne. 13 m.	55°05′	14°41′	I	»	♀	24	[27·2]		»
	» » 14	151	3 miles S of Rønne. 13 m.	55°03′	14°43′	I	»	♀	24	24	0	»
	» » 14	154	3 » » » » 13 »	55°03′	14°43′	I	»	♂	28	28	0	»
	» » 14	158	3 » » » » 13 »	55°03′	14°43′	I	»	♀	28	28	0	»
	» » 14	161	3 » » » » 13 »	55°03′	14°43′	I	»	♀	23	23	0	»
	» » 14	171	3 » » » » 13 »	55°03′	14°43′	I	»	♀	23	23	0	»
	» » 17	164	0·5 miles S of Arnager. 13 m.	55°02′,5	14°47′,5	I	»	♀	25	25	0	»
	1914 May 10	148	1 mile N of Rønne	55°07′	14°41′,5	XII	»		25	26	1	»
	» » 15	159	Gudhjem, Bornholm	55°13′	14°59′	XII	»		23	23	0	weight c. 250 g.
	» » 20	137	3 mile S of Arnager. [17 m.]	55°00′	14°48′	XII	»		26	27	1	good
	» » 23	162	WSW of Arnager, 150 fms. from shore. [6 m.]	55°03′	14°47′	XII	»		25	26	1	slightly injured

Table 10. Continued

Particulars of liberation. Date. Locality. No. of fish etc.	Date	No. on label	Locality reported	Central position (approximately) N	Central position (approximately) E	No. of months between Liberation and Recapture	Nationality of fishing vessel	Sex	Initial size cm.	Ultimate size cm.	Growth (approximately)	Remarks
1913. Exp. No. 2 (Continued)	» » 23	163	SW of Arnager	55°03′	14°47′	XII	Danish		21	22	1	good
	» June 15	169	1 mile N of Gudhjem	55°14′	14°58′	XIII	»		25	26	1	»
	1915 June 6	150	Skillinge, 2 miles from shore. 16 m.	55°28′	14°19′	XXV	Swedish		31	35	4	weight 800 g.
1913. May 27. 3 miles S of Arnager. 55°00′N, 14°47′,5 E. 13 m. 27 turbot liberated (Da 13, No. 174—200) Marking experiment No. 3, 1913	1913 May 27	180	NW of Arnager. 11 m.	55°03′	14°45′,5	0	Danish	♀	23	23	0	good
	» » 27	187	» » » 11 »	55°53′	14°45′,5	0	»	♂	23	23	0	»
	» June 14	179	3 miles S of Rønne. 13 m.	55°03′	14°45′	I	»	♀	25	25	0	»
	» » 14	186	3 » » » » 13 »	55°03′	14°45′	I	»	♂	27	27	0	»
	» » 17	181	0·5 miles S of Arnager. 9 m.	55°02′,5	14°48′	I	»	♀	27	27	0	»
	» » 17	183	0·5 » » » » 9 »	55°02′,5	14°48′	I	»	♀	26	26	0	»
	» » 17	184	0·5 » » » » 9 »	55°02′,5	14°48′	I	»	♀	25	25	0	»
	» » 17	198	0·5 » » » » 9 »	55°02′,5	14°48′	I	»	♀	23	23	0	»
	1914 May 7	188	1 mile W of Helligpeder	55°02′,5	14°48′	XII	»		22	23	1	»
	» June 2	190	SW of Arnager	55°03′	14°47′	XIII	Danish		22	22	0	good

C. Previous experiments with the marking of turbot.

Fulton mentions in XI Annual Report of the Fishery Board for Scotland a few marking experiments with turbots off the coasts of Scotland. By an experiment on November 10. 1892, off Fife Ness, near the North Carr Lightship some specimens were marked and one of these was recovered 43 days later at a point said to be "23 miles SE by E of Montrose", thus, according to Fulton, representing a distance from the place of liberation of 32 miles. It showed no increase in length.

By some experiments in Montrose and St. Cyrus Bays between May and July 1891 56 young turbot, varying in length from 4 to 11 inches (c. 10 to 27 cm) were liberated. One of these was recaptured. About this turbot Fulton writes as follows (p. 195): "It was liberated (at Montrose) on 27th May 1891, and was then exactly 6 inches long. On 31st August, or 96 days afterwards, it was taken again at the same place, and was exactly 8 inches in length — an increase of 2 inches in 3 months. In this case the little brass disc was not tied to the tail, but was fixed at the edge of the fish within the marginal fin, the silk cord passing through the flesh, and being tied losely below".

Trybom mentions a Swedish marking experiment with turbot.[1]

By Gotska Sandön in the Baltic 15 marked turbot were liberated on July 4th 1905. None of these is known to have been recaptured.

In comparing the quoted experiments, the Danish marking experiments appear to have been very successful.

[1] Filip Trybom: Die im Jahre 1906 ausgeführten schwedischen Untersuchungen mit markierten Plattfischen in der Ostsee. Svenska Hydrografisk-biologiska Kommissionens skrifter III. Göteborg 1908.

Resumé.

Mærkningsforsøg med Tunger (*Solea vulgaris* L.).

I Oktober 1906 udsatte vi fra Undersøgelsesskibet „Thor" 184 mærkede Tunger i det nordlige Kattegat. Fisken fangedes med en 50 Fods engelsk Ottertrawl i korte Træk af ca. 1 Times Varighed. Ved Fangsten var Fisken tilsyneladende ganske ubeskadiget, og Udsættelsen fandt Sted paa Fangststederne, af hvilke det ene er beliggende ved Trindelen Nordøst for Læsø i 23—33 Meters Dybde, det andet i den nordlige Del af Læsø Rende ved 18—37 Meters Dybde. Mærket anbragtes i Kroppen tæt ved Rygfinnen (Fig. 1, Side 3). Det bestod af to Benknapper, af hvilke der anbragtes en paa hver Side af Kroppen, og de holdtes sammen med en Sølvtraad. I Knappen paa Fiskens Overside var anbragt en Messingplade med indstemplet Numer. De mærkede Fisk havde en Længde mellem 19 og 37 cm., og de allerfleste var voksne Individer.

Tungens Vandringer.

Kortet Fig. 2, Side 4, illustrerer Beliggenheden af Udsættelsesstederne og Fangststederne for Tungen.[1] Det vil ses, at alle Fangststederne ligger i Kattegat og med et Par Undtagelser alle i det nordlige Kattegat, hvor Udsættelsen fandt Sted. Et af de ved Læsø Trindel udsatte Individer indfangedes 3 Maaneder senere ved Anholt, og et af Individerne fra Forsøget i Læsø Rende indfangedes 17 Maaneder senere Syd for Anholt. Længere Vandringer er ikke iagttaget.

Forsøgene tyder paa, at Kattegat har sin egen Bestand af Tunger, og der foreligger iøvrigt ingen Grund til at tvivle herpaa. Alle Udviklingsstadier af Tungen er kendt fra Kattegat.

Undersøger man Dybderne paa Fangststederne for de mærkede Fisk i de forskellige Maaneder, vil det ses, at i April og Maj indfanges Individerne gennemsnitlig paa langt ringere Dybder end i Efteraaret og i Vintertiden. (Tabel 1, Side 4). Dette hænger sammen med, at i disse Foraarsmaaneder søger Fisken ind i det varme Vand over Grundene for at gyde. Om Efteraaret og Vinteren, naar Overfladevandet er betydelig koldere end Bundvandet, findes de paa større Dybder.

Antallet af indfangede mærkede Tunger.

Af 184 udsatte mærkede Tunger er der ialt indfanget 41 eller 22·3 Procent.[2] Af 66 Individer paa 19—24 cm. er indfanget 14 eller 21·2 Procent. Af 91 Tunger paa 25—29 cm. Længde er fanget 18 eller 19·8 Procent. Af 27 Individer fra 30 til 37 cm. er indfanget 9 eller 33·3 Procent. Af de store Tunger er der saaledes gennemsnitlig indfanget et større Procenttal end af de smaa og mellemstore. (Se Tabel 2, Side 5).

I Løbet af det første Aar efter Udsættelsen indfangedes 13·6 Procent, og i Løbet af 2 Aar var der ialt indfanget 21·7 Procent. Det sidst indkomne Individ blev taget 25 Maaneder efter Udsættelsen.

Af de indfangede 41 Tunger er 18 Individer eller 45 Procent fanget af danske Fiskere, 18 af tyske Fiskere, 4 Individer af svenske Fiskere og et er fundet i Ymuiden og maaske fanget af en hollandsk Fisker. Til Trods for, at Udsættelsen har fundet Sted Vest for den dybe Rende i Kattegat, har dog de fremmede Fiskere fanget flere af Individerne end de danske Fiskere.

Ganske anderledes forholder det sig med Fangsten af mærkede Rødspætter.

De danske Mærkningsforsøg med Rødspætter i Kattegat, der i det store og hele er foretaget Vest for den dybe Rende, har vist, at danske Fiskere gennemsnitlig tager ca. 85 Procent af de indfangede mærkede Fisk, og de fremmede Fiskere kun ca. 15 Procent. Naar de danske Fiskere tager en langt ringere Procentdel af de indfangede mærkede Tunger, ligger dette i, at vore Fiskere i Reglen anvender Snurrevaadet til Fangst af Fladfisk, medens de tyske Fiskere anvender Ottertrawlen. Snurrevaadet, der gaar forholdsvis let hen over Bunden, egner sig udmærket til Fangst af Rødspætter, men ikke slet saa godt til Fangst af Tunger og Pighvarrer, fordi disse Arter trykker sig fastere ned i Bunden. Ottertrawlen, der skærer dybere ned i Havbunden, kan bedre faa fat i disse Arter.

De statistiske Oplysninger om de forskellige Nationers Fangst af Tunger i Kattegat giver et noget lignende Billede af Fordelingen som Mærkningsforsøgene. I „Bulletin Statistique" opgøres Fangsten i Kg. fra de forskellige Nationers Side paa følgende Maade:

[1] Pilespidserne paa Kortene Fig. 2—4 angiver Fangststedernes Beliggenhed. Bogstavet ved Siden af Pilespidsen betegner Fiskerens Nationalitet. D = Dansk, E = Engelsk, G = Tysk, S = Svensk. Er Bogstavet udeladt, er Fisken fanget af danske Fiskere. Tallet ved Siden af Pilespidsen betegner Antallet af Maaneder, der er forløbet siden Udsættelsen fandt Sted, 0 betyder indfanget i samme Maaned, som Udsættelsen fandt Sted, 1 betyder 1 Maaned efter Udsættelsen o. s. v.

[2] Af 110 Tunger, der udsattes fra engelsk Side i August—September 1903 i den sydvestlige Del af Nordsøen, synes kun 3 Fangster at være kendt. Walter Garstang: General Report on the Fishery Investigations. International Fishery Investigations. Southern Area I. London 1905.

	Sverige	Danmark	Tyskland
1906		115808	61721
1907	189	68700	54225
1908	370	48055	73782
1909	2690	59059	47873
1910	2424	72893	65462

Man faar af de her fremdragne Forhold et stærkt Indtryk af, at Spørgsmaalet om Tungens Fredning i Kattegat ikke kan løses fra dansk Side alene, men at det maa tages op til Løsning ved internationalt Samarbejde.

Væksten af de udsatte mærkede Tunger.

Tabellerne 3—5 (Side 6) viser Væksten af de udsatte mærkede Tunger. Sammenlignet med Rødspættens Vækst er Væksten af Tunger paa over 25 cm. Længde langsom. De smaa Individer af 21—24 cm. Længde er gennemsnitlig vokset hurtigere end de mellemstore af 25—29 cm. Længde, og disse er atter vokset hurtigere end de store af 30—37 cm. Længde. Den hurtigste Vækst er iagttaget hos 2 Individer, der ved Udsættelsen havde en Længde af 21 cm. Sytten Maaneder senere havde disse en Længde af 28 cm. Hos Individerne af 25—29 cm. Længde har Gennemsnitsvæksten paa et Aar kun været 1 à 2 cm., og hos de store Individer af 30—27 cm. Længde andrager Væksten paa et Aar kun 0·5—1 cm.

Ved Aldersbestemmelser efter Maalemetoden og ved Otolither har jeg fundet, at Tunger af yngste Aargang (0-Gr.) i det nordlige Kattegat i Oktober har en Gennemsnitslængde af 6—7 cm. og Tunger af næstyngste Aargang (I-Gr.) i August en Gennemsnitslængde af 13—15 cm. Ved Undersøgelse af Otolither og Hvirvler har Thielemann bestemt Alderen af Tunger af følgende Størrelse fra den sydøstlige Del af Nordsøen:

2	Individer	20 cm.	♂ og ♀	I Gr.	Helgoland	30. Okt.	1912
2	—	21 -	♂ - ♀	I -	—	—	—
1	—	32 -	♂	III -	Sydøstlige Nordsø	2. Marts	1912
1	—	33 -	♀	III -	—	— 7. —	—
1	—	32 -	♂	IV -	—	— 7. Jan.	1913
1	—	36 -	♀	IV -	—	— 16. Febr.	1913
1	—	38 -	♀	V -	—	— 2. Marts	1912
1	—	42 -	♀	VII -	—	— 7. Jan.	1913
1	—	43 -	♀	IX -	—	— 15. Febr.	1913
1	—	41 -	♀	X -	—	— 7. Jan.	1913

Disse Aldersbestemmelser viser, at Tungen vokser relativt hurtigt i de første 2 à 3 Aar af dens Levetid, og Mærkningsforsøgene har ganske bekræftet dette. Den langsomme Vækst begynder, naar Kønsmodenheden nærmer sig.

Mærkningsforsøg med Pighvarrer (*Rhombus maximus* L.).

1. Forsøg i Kattegat og Store Belt.

I Oktober 1906 udsatte vi fra Undersøgelsesskibet „Thor" 19 mærkede Pighvarrer i det nordlige Kattegat. Fisken indfangedes med en lille 50 Fods engelsk Ottertrawl, og den var ganske ubeskadiget ved Udsættelsen. Mærket, der var af samme Art som det, der anvendtes til Mærkningsforsøgene med Tunger (se Side 3), anbragtes i Kroppen tæt ved Rygfinnen. Fisken havde ved Udsættelsen en Længde mellem 25 og 42 cm.

Vandringerne af disse Pighvarrer er illustreret paa Fig. 3, Side 9. Alle de indfangede Individer paa et nær er taget i det nordlige Kattegat i ret ringe Afstand fra Udsættelsesstedet, og i Løbet af 1 til 27 Maaneder efter Udsættelsen.

Af de udsatte 19 Pighvarrer indfangedes atter 14 Individer eller c. 74 %. Ni af disse Individer indfangedes i det første Aar efter Udsættelsen, 2 i det andet, 2 i det tredie og 1 i det fjerde Aar. Otte af Individerne indfangedes af danske Fiskere, 6 af tyske Trawlere.

Væksten af de indfangede Fisk er illustreret paa Tabel 8 (Side 10). Tre Individer fra 26—31 cm. Længde, der indfangedes c. 1 Aar efter Udsættelsen, var vokset henholdsvis 2, 3 og 6 cm. eller i Gennemsnit 3·7 cm. Et Individ paa 35 cm., der indfangedes i Januar 1908, var vokset 3 cm. Af to Individer paa 30 cm., der indfangedes efter ca. 2 Aars Forløb, var det ene ikke vokset, medens det andet var vokset 5 cm. Et Individ paa 38 cm., der indfangedes godt to Aar efter Udsættelsen, havde tiltaget 7 cm. i Længde.

I Følge de af mig foretagne Aldersbestemmelser ved Hjælp af Maalemetoden og ved Hjælp af Otolither, vokser Pighvarren i det nordlige Kattegat gennemsnitlig 8 à 10 cm. aarlig i de tre første Aar af dens Levetid. Mærkningsforsøgene viser da hen til, at dens Vækst efter denne Tid er langt ringere.

I Store Belt ved Kerteminde Bugt udsattes 18de Marts 1907 en mærket Pighvarre af 30 cm. Længde. I den følgende Sommer indfangedes den paa den anden Side af Store Belt i Musholms Bugten.

I det sydvestlige Kattegat udfor Fornæs udsattes i April 1912 10 mærkede Pighvarrer, der fangedes med Snurrevaad fra en dansk Kutter. Mærkningen foretoges af Styrmand H. C. Christensen. Udsættelsesstedet og Fangststedernes Beliggenhed er illustreret paa Fig. 3, Side 9. Det vil ses, at disse Fisk gennemgaaende er indfangede i større Afstand fra Udsættelsesstedet end Individerne fra Forsøgene i det nordlige Kattegat. Ialt indfangedes 6 Individer eller

60 Procent. Tre af disse Individer indfangedes ved Nordkysten af Djursland, henholdsvis 1, 5 og 14 Maaneder efter Udsættelsen. To Individer indfangedes Nordøst for Anholt 6 og 23 Maaneder efter Udsættelsen, og 1 Individ indfangedes i Store Bælt udfor Asnæs 5 Maaneder efter Udsættelsen. Fire af Individerne fangedes af danske Fiskere, to af fremmede Fiskere.

2. Forsøg med Mærkning af Pighvarrer i Østersøen ved Bornholm.

I Maj 1913 udsattes ved Bornholms vestlige og sydvestlige Kyster 100 mærkede Pighvarrer af Længde fra 19 til 41 cm. Fisken indfangedes af Bornholmske Fiskere med Garn, og Mærkningen besørgedes af Hr. Fiskeribetjent Kristiansen, Rønne. Udsættelsen fandt Sted tæt ved Fangststederne. Til Mærkningen anvendtes to Sølvplader, der anbragtes ved Rygfinnen, en paa hver Side af Kroppen. Til den ene Plade var loddet en kort Sølvtraad. Denne førtes igennem Kroppen tæt ved Rygfinnen og fastgjordes derefter til den anden Plade, der var numereret.

Udsættelsen af Fisken fandt Sted paa tre forskellige Steder i Nærheden af Bornholms Kyster (se Fig. 4, Side 12). 20 Individer udsattes 3 Sømil Vest for Hammeren i 24 Meters Dybde. 53 Individer udsattes 3 Sømil WSW for Rønne ved 26 Meters Dybde, og 27 Individer udsattes Syd for Arnager ved 13 Meters Dybde.

Vandringer.

Fig. 4, Side 12, illustrerer Udsættelsesstederne og Fangststederne for de mærkede Fisk. Det er karakteristisk, at alle Fangstpladserne undtagen et findes tæt ved Bornholms Kyster.

Betragter man Tallene ved Pilespidserne ved Bornholms Kyster, vil det ses, at disse kun omfatter Zifrene 0, 1, 2, 12 og 13. Tallet angiver Antallet af Maaneder mellem Udsættelsen og Genfangsten, og da Udsættelsen fandt Sted i Maj, falder alle Fangsterne indenfor Maanederne Maj—Juli.

Dette hænger sammen med, at det kun er i Maanederne April—Juli, at der drives Fiskeri efter Pighvarrer ved Bornholms Kyster.

Alle Fangstpladserne 0, 1 og 2 ligger nærmere Kysten og paa grundere Vand end Udsættelsesstederne. Dette staar i Forbindelse med, at Fisken i Maj og Juni Maaneder søger ind paa det grunde Vand for at gyde. Ved Forsøget Nr. 3, hvor der udsattes 27 mærkede Fisk, indfangedes 8 i Maj og Juni i et Cirkeludsnit paa ca. 30°. De mærkede Fisk kan da ikke have vandret ligeligt i alle Retninger, men de har haft en Forkærlighed for at søge ind imod det grunde Vand.

I Maj og Juni 1914 indfangedes 9 mærkede Pighvarrer, deraf 7 paa Vest- og Sydvestkysten og 2 paa Østkysten ved Gudhjem. Disse sidste stammede fra Forsøget ved Rønne. Om de har tilbagelagt Vejen Nord om Øen eller Syd om Øen kan ikke vides.

Interessant er Fangsten af et Individ ved Sveriges sydlige Kyster ved Skillinge paa 16 Meters Dybde 25 Maaneder efter Udsættelsen. Bestanden ved Bornholm har da Berøring med Bestanden ved de svenske Kyster, og der kan næppe være Tvivl om, at den ogsaa har Berøring med Bestanden ved de tyske Østersøkyster.

Antallet af indfangede mærkede Pighvarrer.

Tabel 10 (Side 13) viser Størrelsen af de udsatte Individer og Antallet af Fangsten af hver Størrelsesgruppe. Af 100 udsatte Pighvarrer er ialt indfanget 46 Individer, hvoraf 36 i de første 2 Maaneder efter Udsættelsen. I Løbet af det første Aar efter Udsættelsen indfangedes i alt 43 Individer. Procenttallet af samtlige indfangede Fisk af forskellige Størrelsestrin vil ses af nedenstaaende Oversigt:

	Antal udsatte	Antal indfangede	Procent indfangede
19—24 cm.	33	15	45·5
25—29 -	53	27	50·9
30—34 -	11	4	36·4
35—41 -	3	0	0·0

Det fremgaar heraf, at der af de middelstore Individer paa 25—29 cm. er genindfanget et større Procenttal end saavel af de mindre som af de større Fisk.

Ved Forsøget Vest for Hammeren indfangedes 55 %, ved Forsøget SV for Rønne 47·2 % og ved Forsøget S for Arnager 37 % af de udsatte Fisk.

Af de 46 genindfangede mærkede Pighvarrer er de 45 indfangede af danske Fiskere tæt ved Bornholm, og 1 Eks. er indfanget af en svensk Fisker tæt ved Sveriges Kyster.

Væksten af de ved Bornholm udsatte mærkede Pighvarrer.

Det fremgaar af Tabel 11, Side 14, at Væksten af 9 Eksemplarer af 21—26 cm. Længde i Løbet af et Aar kun har andraget i Gennemsnit 0·8 cm. Denne ringe Vækst staar i Forbindelse med, at Pighvarren ved Bornholm ved den nævnte Størrelse allerede er kønsmoden. Et enkelt Eks. paa 27 cm. Længde voksede i Løbet af 2 Maaneder fra 27 til 29 cm., og et Eksemplar paa 31 cm. voksede i Løbet af 25 Maaneder fra 31 til 35 cm.

Det vil ses, at Væksten af Pighvarren ved Bornholm staar langt tilbage for Væksten i det nordlige Kattegat (se Side 17).

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» 3 Johan Hjort og C. G. Joh. Petersen: Kort Oversigt over de internationale Fiskeriundersøgelsers Resultater med særligt Henblik paa norske og danske Forhold. 10 Tavler. 1905. 54 S. Kr. 3.50.

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» 7 A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet med nogle Bemærkninger om de øvrige Flynderarter og Flynderfiskerier i samme Farvand. 23 Tavler, 14 Textfigurer. 1912. 158 Sider. Kr. 3.00.

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